Economics of Education Review, Vol. 12, No. 3, pp. 257–265, 1993.
Printed in Great Britain.

0272–7757/93 $6.00 + 0.00

The Demand for Higher Education in Puerto Rico

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Abstract — Enrollment models are estimated for three Puerto Rico university systems. The opportunity cost and benefit to education are both measured as expected wage rates, a formulation which appears appropriate given the island's historically high unemployment rates. From the consumption function literature support is found for short-term, rather than a future oriented, decision framework to underlie the models. The models also include variables to test a market segmentation hypothesis. The empirical estimates mostly have good statistical properties, and the hypothesis that the universities are not substitutes for one another is accepted. The study also replicates findings that explain student decisions to undertake higher education in terms of reward motivated behavior. The higher education demand function can be identified since universities in Puerto Rico generally finance their expansion by long-term loans and bond issues, rather than through tuition hikes.

INTRODUCTION

THE PURPOSE of this paper is to develop and estimate a model of the demand for university education in Puerto Rico. Of the larger institutions on the island, one is public and three are private. In addition, there are several smaller colleges and universities that attend to the demand. In 1987, total enrollment in higher education was 156,082, with 61.5% at private universities (Universidad Inter-Americana de Puerto Rico, 1988, p. 18). About 4.75% of Puerto Rico's population was enrolled in postsecondary institutions in that year, a figure that compares favorably to the percentage for the U.S.A. as a whole (about 5% in 1980), given the much lower standard of living on the island.

Universities must understand the determinants of enrollment, to plan for the future and compete effectively for students. Since 1983, enrollment growth has slowed in Puerto Rico, particularly in the private institutions, and a financial crunch has ensued. One institution, Inter American University, raised entrance requirements at its San Germán campus, further constraining enrollment growth. A heavy dependence on federally funded financial aid, such as Pell Grants, has created additional risk in this period of large budget deficits and possible cutbacks.

In Puerto Rico a weakness in any sector of the economy is threatening, since the unemployment rate presently hovers around 17%. Universities are an important component of the service sector, and any retrenchment or outright failure there can have a severe impact on the surrounding communities. Private universities will have to search for revenues more creatively, perhaps requesting direct public support, justified by their presumed socially beneficial spillover effects. However, public university and K-12 education, with very unsatisfactory levels of funding, block out this option on the island.

Puerto Rican universities have not likely considered optimal pricing policies. There is some evidence that the inflation rate is ignored in setting tuition charges (King, 1989). In general, these charges can be developed using estimates of demand elasticities. One possibility is to implement cost related tuition structures (Hoenack and Weiler, 1975).

The aim of this study is to estimate, using time series data, empirical enrollment functions for three multi-campus university systems: Inter American University (IAU), Catholic University (CU), and the public University of Puerto Rico (UPR). In addition, there is a test of the hypothesis of institutional competition for students versus the alternative of each operating in an isolated market

[Manuscript received 11 October 1990; revision accepted for publication 1 February 1993.]

segment. Some possible implications for tuition planning will be discussed.

There is a large amount of literature on higher education demand. Cross section studies include Corazzini *et al.*, Hoenack and Weiler (1975, which also contains time series models); Bishop; Knudsen and Servelle (1978); Doyle and Cicarelli (1980); Fuller *et al.* (1983) and Schwarz (1985). Time series studies include Galper and Dunn (1969); Hight (1975); Hoenack and Weiler (1975); Lehr and Newton (1978); Polzin (1984); Paulsen and Pogue (1988); Huijsman *et al.* (1986) (for the Netherlands); and Nakata and Mosk (1987, for Japan). These are by no means exhaustive of the research available on the topic. Model specifications vary. Among the independent variables used are measures of the future benefit to higher education, foregone earnings, direct costs, the military draft, the population pool, distance, income and financial aid. A brief discussion follows of four that have considered competition among universities.

Hight (1975) finds a statistically significant cross-tuition effect in a time series estimate of enrollment in public, but not in private, institutions. Knudsen and Servelle (1978) in cross-section estimates found no statistically significant cross-tuition effects for groups of private universities classified according to whether the competition is private or public. Doyle and Cicarelli (1980) for public college enrollment, and Paulsen and Pogue (1988) for private institution enrollment, did not use cross-tuition as the competition variable. Competition is measured in the first through the number of competing public colleges in a given state, while in the second through public enrollment divided by independent college enrollment. The competition variable had the expected negative sign in both, but was statistically significant only in the first.

The present study differs mainly in three ways. First, Puerto Rico data are used. Second, the education's opportunity cost (foregone earnings), and benefit (earnings after graduation) are each measured as an expected wage rate. While at least one previous study used both the wage rate and the unemployment rate (Corazzini *et al.*), none has relied on the Harris and Todaro (1970) expected wage rate approach, which may be more suitable for a semi-developed area such as Puerto Rico. Third, competition among individual universities is considered in terms of market structure hypotheses, and cross-tuition effects are tested on the enrollments of individual rather than on groups of institutions.

THEORETICAL ASPECTS

Some studies emphasize higher education as investment in human capital, focusing on the rate of return. In intermediate and industrialized countries the average rates of return to higher, as well as secondary education, are 13 and 12%, respectively (Psacharopoulos, 1988, p. 101). Such studies suffer from cross-section biases (Rosen, 1977, p. 6) and from ignoring the costs of education, but at least indicate that a university education can be economically valuable. A study using Puerto Rico 1980 Census data finds a private rate of return to higher education of 14% for men and 31% for women (Cao García and Matos Díaz, 1988).

A basic hypothesis is that the demand for higher education is a positive function of the rate of return. As the average rate of return rises, the rates of return for most individuals will likely rise as well. If rising rates are perceived in the market for higher education, the response may be increased enrollment. A response to changes in the rate of return means that prospective students consider their entire lifetime future income stream, and are future oriented. Consumption theory has incorporated this view, with the permanent income and life cycle theories. However, a time series on the rate of return is difficult to generate, and there are no available annual estimates of it for Puerto Rico. An apparently acceptable alternative is to rely on near term determinants of educational investment.

In consumption theory, forward-looking approaches have not supplanted a short term approach — where consumption is a function of current disposable income — for reasons such as capital market imperfections (Dolde, 1978, p. 413). Uncertainty about the future also gives current circumstances greater weight (Ackley, 1978, p. 567), not only in consumption, but in investment decisions as well. Empirically, estimates of consumption functions based on the short-term approach may be just as satisfactory as those based on an orientation to the future (Ackley, p. 569). Consequently, the parallel approach is taken in the present paper, to see if a university enrollment function not based on lifetime future income streams is empirically acceptable.

The enrollment decision is complex, and expected economic benefits may be an insufficient motivator. Also involved are preferences, expectations about university life, fears, hopes, problems of self-esteem, and so on. Unfortunately, these factors

cannot be considered in the present study, which uses an aggregate time series approach. But one can take into account the most important short-term economic considerations. Among these are the direct costs (primarily tuition) and opportunity cost or the earnings foregone by working part-time or not at all, sustained by the vast majority of students. By measuring the benefits as earnings immediately after graduation, a short-term benefit–cost ratio for higher education can be constructed, and used to explain the enrollment decision.

A proxy for the direct cost component is the real credit-hour tuition charge. For the opportunity cost, and the benefit to higher education, developing adequate measures must take into account the particular circumstances of the Puerto Rican economy. Puerto Rico, with a 1987 *per capita* income of $5530 (World Bank, 1989, p. 230), manifests historically high unemployment rates and lower average wage rates compared to the U.S. (King, 1990). As an alternative to studying, full time work is difficult to find and, if available, likely to pay the minimum wage.

This paper draws on the Todaro migration model, where migration is encouraged by an expected urban wage rate larger than the rural wage rate (Harris and Todaro, 1970). The opportunity cost of higher education is measured as an expected wage rate, by multiplying the real federal monthly minimum wage rate by the 20–24 age group employment rate. Given the available data groupings, this is the rate most likely applicable to recent high school graduates without college degrees.

Prior to 1984 the U.S. federal minimum wage prevailing did not apply to all sectors in Puerto Rico, but coverage increased gradually over time. In 1990 a three-tier minimum wage applied, with the highest tier corresponding to the mainland minimum. For 1990 and the pre-1984 period, the real federal mainland minimum will be used as a proxy for the average real minimum wage rate, thus somewhat overstating the opportunity cost. The benefit from higher education is measured by multiplying the average monthly wage of college graduates immediately after graduation by the 25–34 age group employment rate. The benefit–cost ratio is thus the benefit measure divided by the opportunity cost measure.

Constructing the benefit series required making two assumptions. There are 1984 data on monthly earnings of college graduates in several professions the year after graduation (Cao García, p. 64). A proxy for college graduate average earnings can be obtained by assuming that they are highly correlated with average monthly employee compensation and that the relationship holds in other years as it does in 1984. This proxy is the average monthly employee compensation multiplied, for each year in the estimation period other than 1984, by the ratio of college earnings to average compensation as it applies in 1984. The proxy is likely to be closer in magnitude to the "true" college graduate earnings series than the average compensation series.

In addition, enrollment depends on the size of the potential enrollee pool, mainly the cohort of high school current year and previous 3 year graduates. At the UPR, first to fourth year undergraduates represent over 97% of the annual total for 1961–1990. These are mainly drawn from high school graduating classes up to 4 years earlier. The Puerto Rico data series is an underestimate of the number of high school graduates (due to reporting problems), but is probably highly correlated with the true figure.

The availability of financial aid is a crucial factor in permitting enrollment of many students. The Federal Government provides most of the aid, supplying it to eligible students upon enrollment. In this sense, the total dollar amount of aid actually given is endogenous and a function of enrollment. However, the quantity of aid available for each student who qualifies can be a determinant of enrollment. Since 1975, most students in Puerto Rico have been eligible for the Pell grant, which covers a good part of the direct costs of education. Its effect on enrollment can be determined by use of a dummy variable, taking the value of zero for the years prior to 1975 and the value of one for the subsequent years. Data limitations rule out the use of a variable such as average financial aid per student.

The possibility of competition among universities is an important issue. To what extent are universities substitutes for each other? It is possible that the higher education market is segmented because of differences in admission standards, in available majors and course offerings, in location, and in other institutional characteristics. This leads to a maintained hypothesis of zero substitutability, which can be tested relative to the alternative that the institutions are substitutes for one another. To

perform the test, cross-tuitions must be included as variables in the model.

Additionally, enrollment may also be determined by publicity and recruitment activities, often joint products with sporting events or special conferences and lectures. Newspaper and television advertising is occasionally used. However, the institutions under consideration and their programs are well known on the island. Publicity is likely to be most effective when it is used to inform of new programs, but these are infrequently developed. Hence omitting this type of variable is probably not a very serious source of bias. Enrollment may also depend on variations in institutional structural conditions, such as a change in programs, majors, course offerings, faculty, facilities, admission standards, and so on. These difficult to measure variables perhaps at best should be considered as random elements.

To summarize, in this study undergraduate enrollment in a particular university is predicted to be a positive function of the following: the benefit–cost ratio, the size of the pool of potential enrollees, cross-tuitions and financial aid. A university's own tuition is expected to have a negative influence.

EMPIRICAL ANALYSIS

On the basis of the above specification, three demand for higher education equations are estimated via ordinary least squares with annual time series data for 1962–1990. Conformity to the characteristics of the classical normal linear regression model is assumed. The *a priori* expectations are confirmed or rejected by examining the signs of the estimated coefficients and the outcome of the hypothesis tests on them. The assumption of no first-order autocorrelation is tested using the Durbin–Watson statistic. All the observations are transformed to their natural logarithms, permitting an elasticity interpretation of the coefficients.

Identification of the demand equations seems to depend on whether a university increases tuition to supply more places for students. If universities behave this way, a supply function must be considered. In this case, as Becker puts it: "Identification of a demand equation requires that we know of variables that affect supply but do not influence demand" (p. 162). University administrators and their overseers (boards of trustees, regents, higher education councils, and so on) may be inclined to raise tuition in response to rising costs, declining public subsidies, or to expand the places available for students. It would be impossible, without knowing the actual decision-making process, to assign a weight to any one particular motive. Hoenack and Weiler provide *a priori* arguments which exclude tuition hikes for expansion at the University of Minnesota, and permit identification of the enrollment demand curve (cf. Hoenack and Weiler, 1979, p. 90, footnote 3). In the present study an *a priori* argument can also be made for assigning a very small weight to the place increasing motive.

With constant or declining average operating costs,[1] a university could supply more places without raising tuition, since revenues from new students at existing rates would cover the additional operating expenses. However, significant expansion usually entails financing capital outlays for new buildings, new campuses, and so on. With self-financing, a tuition increase would be a virtual necessity, but in Pureto Rico even private universities typically rely on bond issues and long-term loans. Thus, capital expansion need not be a significant motive for the observed hikes. To an extent this argument is valid, and if there are no other supply variables, an enrollment supply function is meaningless in the present context. All the independent variables can be considered as explaining only demand, thus permitting identification and justifying the use of ordinary least squares estimation.

This argument is reinforced by examining tuition behavior, which at all three universities appears consistent with the objective of admitting all qualified applicants. Pell grant scales in practice constrain tuition levels at the private universities (Prieto). UPR depends on a regulatory body, the Council of Higher Education, for setting tuition. Changes occur only after extensive study and consultation with the university community and the public. In terms of annual averages, real tuition actually decreased in 1962–1990, by about two tenths of a per cent per year, while enrollment increased by about 3% per year.

Enrollment in 1962–1990 at IAU and CU grew on average, respectively, about 8% and 5% per year. On the other hand, real credit unit cost increased at IAU on average by only about 1% per year (but actually declined during 1970–1990, at an average annual rate of about three tenths of a per cent). Credit unit costs increased by about 2% per year on average for 1962–1990 at CU (and only by four

tenths of a percent per year in 1970–1990). By U.S. standards, where tuition increases often far outpace inflation, it seems that the increases in three Puerto Rican institutions would just about cover increased operating costs. It is doubtful the infrastructure to accommodate increased enrollment has been even partly financed with tuition raises.

The variable names and definitions are:

1. Enrollment variables:
ENROLIAU, ENROLCAT, ENROLUPR, the log of total fall undergraduate enrollment at the Inter American University, the Catholic University, and the public University of Puerto Rico, respectively. Each is a proxy for the demand for higher education at the respective university.

2. Real credit cost variables:
COSTIAU, COSTCAT, COSTUPR, the log of the real dollar cost of a credit unit at IAU, CU, and UPR, respectively (real values are obtained via deflating by the Puerto Rico consumer price index, with 1954 as base year). A proxy for the direct cost of education at each university.

3. Pool of students variable:
HIGH, the log of the total number of spring high school graduates in Puerto Rico over 4-year periods (e.g. the value of this variable for 1990 represents the total sum of high school graduates in the period 1987 through 1990). A proxy for the size of the pool of potential enrollees.

4. The benefit–cost ratio:
RATIO, the log of the expected annual wage rate of college graduates divided by the expected annual wage rate of college age individuals. A proxy for the net benefit to higher education. It is computed as indicated above, in the section on theoretical aspects.

4. Financial aid:
PELL, a dummy variable indicating the years in the sample over which the Pell Grant applies. Takes the value of 1 in the period 1975–1990, an 0 in 1962–1974.

Data to construct these variables was obtained from the respective universities, the Puerto Rico Planning Board, the Puerto Rico Department of Labor and Human Resources, and the Puerto Rico Department of Public Instruction.

The empirical model attempting to explain enrollment at IAU, with the respective *a priori* signs for the coefficients of each variables, is:

$$\text{ENROLIAU} = \text{CONSTANT} + \bar{A}_1(\text{COSTIAU}) + \bar{A}_2(\text{COSTUPR}) + \dot{A}_3(\text{COSTACAT}) + \dot{A}_4(\text{HIGH}) + \dot{A}_5(\text{RATIO}) + \dot{A}_6(\text{PELL}) + e_1.$$

The empirical models for CU and UPR are similar:

$$\text{ENROLCAT} = \text{CONSTANT} + \dot{B}_1(\text{COSTIAU}) + \dot{B}_2(\text{COSTUPR}) + \dot{B}_3(\text{COSTCAT}) + \dot{B}_4(\text{HIGH}) + \dot{B}_5(\text{RATIO}) + \dot{B}_6(\text{PELL}) + e_2$$

and,

$$\text{ENROLCAT} = \text{CONSTANT} + \dot{C}_1(\text{COSTIAU}) + \bar{C}_2(\text{COSTUPR}) + \dot{C}_3(\text{COSTCAT}) + \dot{C}_4(\text{HIGH}) + \dot{C}_5(\text{RATIO}) + \dot{C}_6(\text{PELL}) + e_3.$$

EMPIRICAL RESULTS

Table 1 contains the regression coefficient estimates, respective *t*-values (in parentheses), Durbin–Watson (D–W) statistic values, and R^2 values. All were estimated by ordinary least squares.

The D–W statistics for all regressions lie in the

Table 1. Regression coefficients and *t*-ratios (in parentheses) for enrollment demand equations

	Dependent variables		
	ENROLIAU	ENROLCAT	ENROLUPR
Independent variables			
CONSTANT	−4.24	−4.58	3.19
	(−1.55)	(−2.66)	(2.54)
COSTIAU	−0.41	−0.26	0.19
	(−1.70)*	(−1.70)*	(1.75)†
COSTUPR	−0.03	−0.09	−0.15
	(−0.40)	(−1.86)†	(−4.56)‡
COSTCAT	0.25	0.03	0.10
	(1.27)	(0.20)	(1.05)
RATIO	0.86	0.24	0.49
	(4.29)‡	(1.90)‡	(5.32)‡
HIGH	1.21	1.23	0.58
	(4.70)‡	(7.58)‡	(4.87)‡
PELL	0.38	0.08	−0.12
	(4.07)‡	(1.42)*	(−2.71)‡
R^2	0.98	0.98	0.98
D–W	1.16	1.06	1.56

One-tail test significance levels (for all coefficients except the constant term): ‡1%, †5%, *10%.

indeterminate range at the 5% and 1% significance levels. The R^2 of 0.98 in the three regressions indicates a good statistical fit.

The results are consistent with the theoretical predictions for a number of variables. Especially notable is the performance of the benefit–cost ratio, with a positive and highly significant (at the 5% level or better) coefficient in all three regression. This replicates findings in industrialized countries, where students respond rationally to the net rewards of education (Freeman, pp. 370–375).

Regarding own institution tuition charges, the results are consistent with *a priori* expectations in the cases of IAU and UPR. In the former, the elasticity was −0.41, with a 10% significance level, and in the latter, −0.15, at the 1% level. However, enrollment at CU showed virtually no response to tuition changes (a statistically non-significant coefficient of 0.03).

Becker summarizes the results of studies on enrollments in 4-year public institutions, showing the tuition elasticity in the range of −0.6 to −1.2 (p. 187). The estimate for the public UPR was much lower (in absolute value). One possible explanation is that UPR enrolls proportionately more aid-eligible low income students than a typical U.S. public institution. The students are more likely to be able to cover tuition increases with financial aid, and continue in that institution.

Becker also notes that the absolute value of the elasticity in private schools is likely to be larger "than that of like-quality but less expensive public schools" (p. 187). The private IAU elasticity of −0.41 is indeed larger in absolute value than the UPR elasticity. However, IAU may not have the same academic standards as UPR. The higher IAU elasticity may be due to its charging higher tuition than UPR and, therefore, its students are more sensitive to cost increases.

In this study there is hardly evidence for substitution effects. The three university systems, possibly for the reasons suggested above, seem to operate in separate markets and are not noticeably price-competitive with each other. In only one case was the cross-tuition coefficient positively signed and significant. In the UPR enrollment regression, IAU's tuition coefficient was 0.19, and significant at the 5% level. In all other cases the cross-tuition coefficients were either of the incorrect sign or not significant.

For the relationship between private and public institutions, Becker indicates that some previous research has uncovered positive cross-elasticities, with the magnitude depending on the institutions involved (p. 187). However, Hoenack and Weiler found high correlations among tuition variables, and include only the own-tuition variable in their time series regression for enrollments at a Minnesota college, interpreting its coefficient "as the effect of the overall level of tuition at all the state's institutions" (1975, p. 342). They rely primarily on cross-section estimates, where travel costs (based on distance the nearest campus) are a proxy for tuition. Their time series results serve to generally confirm the cross-section estimates, where a $100 rise in tuition results in a 9% decrease in freshmen enrollment (1975, p. 344).

In the present study the correlations between UPR and IAU tuition, and UPR and CU tuition, were −0.13 and −0.28, respectively, while the IAU-CU tuition correlation was 0.81. From the magnitudes of these correlation coefficients it is not possible to automatically infer that multicollinearity is obscuring a possible cross-tuition effect. As a further check, regressions for particular university enrollments were estimated without using the own tuition variables, but including the two relevant cross-tuition variables, as well as others which include only one cross-tuition variable. There was no appreciable change in the results. Finally, an eigenvalue analysis shows little interdependence among the independent variables of the regressions.[2]

Another important result is that the pool of potential enrollees appears as a powerful determinant of enrollment. The coefficient of HIGH was positive and significant at the 1% level in all three regressions. In the case of IAU and CU, the elasticity exceeded one. Finally, the availability of the Pell Grant, as of 1975, seems to have had a positive impact on enrollment at the two private institutions. For IAU the coefficient was 0.38, significant at the 1% level, while for CU the coefficient was 0.08 and significant at the 10% level. In the UPR regression, the coefficient was −0.12, and significant at the 1% level. Perhaps these results indicate a Pell grant-induced shift in enrollment from the public university to the more expensive private ones, primarily IAU. Substitution, if it exists, may be operating more through the availability of financial aid than through changes in relative tuition.

CONCLUSION

The model based on the short run view of enrollment determination produced empirical estimates with good statistical properties. Most importantly, the results are consistent with rational, reward motivated behavior. This replicates other empirical results on the demand for higher education. Within certain limitations, the own-tuition elasticity results for UPR and IAU point to the possibility of increasing revenue through tuition hikes, if enrollment is closely correlated with the total number of credit hours actually demanded.

Public funding for UPR has remained virtually stagnant for many years. This led to a tuition increase, followed by only transitory student protests and demonstrations. Clearly, this strategy is viable for reducing dependence on the state budget allocation. With the UPR tuition-enrollment elasticity of -0.15 the expectation is for tuition increases to produce significant revenue additions for the university. Rising operating costs make a larger university budget a virtual necessity, particularly to avoid program cutbacks. Higher tuition charges aid university development when public funding is maintained, while providing a cushion should it be reduced.

A major issue concerning UPR tuition hikes is to avoid impeding a qualified student's access to the university because of financial reasons. The UPR plan proposes to guarantee financial aid to students who otherwise could not attend. Additionally, there is also some concern for the financial burden it would place on middle class families. Aside from redistributive issues, the social benefit of tuition hikes are still being questioned, at least in some segments of the academic community (Leslie and Brinkman, p. 185). However, at present, a substantial rise in the percentage of the state budget allocated to UPR is unlikely, and tuition increases seem to be the only way of obtaining significantly greater revenue.

At IAU, public funding primarily comes from the Federal Government through tuition Pell Grants. Tuition accounts for over 90% of revenue. IAU budgeted spending tends to be frozen towards the end of the academic year, and deficits are continually projected. The administration has been reluctant to raise tuition sharply, out of fear of student protests, and to retain market share. A recent tuition increase was called a building fee. However, if the calculated elasticity of -0.41 is indicative of the future tuition–enrollment relationship, tution increases could be a significant part of increased revenue, complementing income from other sources, such as auxiliary enterprises owned by the university. IAU should be concerned, however, over the extent to which many students can afford tuition payments in excess of the Pell Grant. At higher tuition levels, further increases may be subject to increasing demand elasticity and lower increments to revenues.

Another concern, as an anonymous referee pointed out to me, is that elasticities for new students may be larger than for continuing students. While it was not possible to obtain data to estimate new student own-price elasticities for the private universities, an estimate for UPR can be provided. In a regression similar to the one above, the natural log of first year enrollment was explained by the same variables, except for the measure of high school graduates, which in this case was the natural log of current year graduates. The coefficient of the own price variable was -0.13, with a t-value of -2.23, significant at the 5% level in a one-tail test. This is very similar to the elasticity of -0.15 found in the UPR total undergraduate enrollment regression. It may be the case in Puerto Rico that elasticities are, in general, similar for new and continuing students. Needless to say, this topic requires exploration and interpretation, and could benefit from future research.

At the very least, the universities should consider keeping tuition increases moderately ahead of inflation on a consistent basis. This could be part of a strategy to cope with revenue shortfalls resulting from possible declining future enrollment pools, or to meet the ever increasing expenses of operating and improving a university in a technologically sophisticated economy.

If the hypothesis that the universities are not substitutes for one another is accepted, decision making can operate under fewer constraints. In particular, pricing decision can be less dependent on the fees that other universities currently charge and are likely to charge in the future. However, while the results of this study offer some support for this point of view, it is important to note that there are other smaller and more localized universities and colleges in Puerto Rico, such as the Ana Mendez Foundation system, Sacred Heart University, and numerous specialized insitutions. The question of

substitutability was not studied in relation to these. Some of them may be substitutes for the institutions studied and among themselves. Furthermore, it is possible that there are non-price substitutions among specific campuses of the three institutions studied, but that this effect cannot be examined in models based on system-wide data.

There are many other dimensions involving university finances that have to be considered, but are beyond the scope of this paper. These involve alumni and corporate support, subsidiary enterprises, federal grants, marketing of research and consulting services, recruiting international students, and so on. However, from a managerial economics perspective, the insights offered on tuition charges in this study could be particularly valuable. Where there are inelastic own-tuition coefficients, the presumption is that tuition increases will rapidly increase revenues.

Acknowledgements — I am grateful to Stephen A. Hoenack, Associate Editor of this journal, and to an anonymous referee, for comments on earlier versions of the paper, which were of great help. However, I take exclusive responsibility for any remaining deficiencies.

NOTES

1. This is not an unreasonable assumption. Commenting on a survey of studies on scale economies, Hoenack notes that in general, "two-year and four-year institutions exhibit economies of scale while the results are mixed for research universities" (1990, p. 137).
2. Inspections were made of the coefficient variance decomposition proportions that correspond to each eigenvalue for the above regressions, all of which have the same independent variables (cf. Belsley *et al.*, pp. 112–113). They show that none of the eigenvalues accounts for a high proportion of the variance of more than one coefficient of the regression variables. Specifically, for the eigenvalues with condition indexes greater than 10, none has variance decomposition proportions greater than 0.5 on more than one of the regression estimated coefficient variances pertaining to variables. In other words, there seems to be little evidence of interdependence among the independent variables.

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